

| Question Number | Answer                                                                                                                                                                                                                                                                                                 | Mark       |
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| <b>1(a)</b>     | <p><b>The only correct answer is D – Schwann cell</b></p> <p><i>A is not correct because myelin is produced by the Schwann cell.</i></p> <p><i>B is not correct because myelin is produced by the Schwann cell.</i></p> <p><i>C is not correct because myelin is produced by the Schwann cell.</i></p> | <b>(1)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                   | Mark       |
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| <b>1(b)(i)</b>  | <p><b>The only correct answer is B – an electrical insulator</b></p> <p><i>A is not correct because myelin does not act as an electrical conductor.</i></p> <p><i>C is not correct because myelin is impermeable to potassium ions.</i></p> <p><i>D is not correct because myelin is impermeable to sodium ions.</i></p> | <b>(1)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                  | Mark       |
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| <b>1(b)(ii)</b> | <p><b>The only correct answer is A – axon</b></p> <p><i>B is not correct because myelin surrounds the axon.</i></p> <p><i>C is not correct because myelin surrounds the axon.</i></p> <p><i>D is not correct because myelin surrounds the axon.</i></p> | <b>(1)</b> |

| Question Number | Answer                                                                                 | Additional Guidance                                                                                   | Mark       |
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| <b>1(c)(i)</b>  | 1. 5.7 and 2.7 ;<br>2. difference divided by the smaller value ;<br>3. $111 / 111.1$ ; | <b>MP1 ALLOW</b> 5.6 to 5.8 and 2.7 to 2.8<br><br><b>MP3 ALLOW</b> ECF if they divide by larger value | <b>(3)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Additional Guidance                                         | Mark       |
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| <b>1(c)(ii)</b> | 1. as diameter of neurone increases speed of conduction increases for both ;<br>2. above $1\text{ }\mu\text{m}$ myelinated neurones have a faster speed of conduction than non-myelinated neurones / below $1\text{ }\mu\text{m}$ non-myelinated neurones have a faster speed of conduction ;<br>3. the diameter has a greater effect on the speed of conduction of a myelinated neurone / eq ;<br>4. in myelinated neurones linear relationship but not linear in non-myelinated neurone ; | <b>MP3 ALLOW</b> gradient is steeper in myelinated neurones | <b>(2)</b> |

| Question Number  | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                  | Additional Guidance                                                                                                                | Mark       |
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| <b>1(c)(iii)</b> | <ol style="list-style-type: none"> <li>1. idea that myelin sheath insulates the axon ;</li> <li>2. there are breaks in the myelin sheath of myelinated fibres / nodes of Ranvier ;</li> <li>3. action potentials occur at the nodes only / eq ;</li> <li>4. nerve impulses jumping from node to node / saltatory conduction ;</li> <li>5. in non-myelinated fibres action potential has to be generated all along the axon ;</li> </ol> | <p><b>MP3 and 5 ALLOW</b><br/>depolarisation</p> <p><b>MP4 ALLOW</b> action potential / depolarisation jumps from node to node</p> | <b>(3)</b> |

| Question Number | Answer                                                                      | Additional Guidance       | Mark       |
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| <b>2(a)</b>     | 1. $90 \text{ (mm)} \div 50\,000$ ;<br>2. $1.8 \times 10^{-3} \text{ mm}$ ; | <b>ALLOW</b> 91 / 9 / 9.1 | <b>(2)</b> |

| Question Number | Answer                                                                                                                                                                                                                      | Mark       |
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| <b>2(b)(i)</b>  | <p><b>The only correct answer is D</b></p> <p><i>A is not correct because D shows a sarcomere</i></p> <p><i>B is not correct because D shows a sarcomere</i></p> <p><i>C is not correct because D shows a sarcomere</i></p> | <b>(1)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                | Mark       |
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| <b>2(b)(ii)</b> | <p><b>The correct answer is A</b></p> <p><i>B is not correct because it contains myosin and actin</i></p> <p><i>C is not correct because it contains regions with both actin and myosin</i></p> <p><i>D is not correct because it contains regions with both actin and myosin</i></p> | <b>(1)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                               | Mark      |                |     |
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| 2(b)(iii)       | <p>The correct answer is B - <table><tr><td>decreases</td><td>stays the same</td></tr></table></p> <p>A is not correct because part B stays the same</p> <p>C is not correct because part A decreases and part B stays the same</p> <p>D is not correct because part D decreases</p> | decreases | stays the same | (1) |
| decreases       | stays the same                                                                                                                                                                                                                                                                       |           |                |     |

| Question Number | Answer<br>Additional Guidance                                                                                                                                                                                                                                                                                                                   | Mark       |
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| <b>2(c)</b>     | <p><b>The correct answer is A – few mitochondria and few capillaries</b></p> <p><i>B is not correct because fast twitch fibres have few capillaries</i></p> <p><i>C is not correct because fast twitch fibres have few mitochondria</i></p> <p><i>D is not correct because fast twitch fibres have few mitochondria and few capillaries</i></p> | <b>(1)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                        | Additional Guidance                                   | Mark       |
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| <b>2(d)</b>     | <ol style="list-style-type: none"> <li>1. calcium ions {are released from sarcoplasmic reticulum / enter the sarcoplasm } ;</li> <li>2. calcium ions bind to troponin ;</li> <li>3. (change in shape of troponin) moves tropomyosin away from myosin binding site ;</li> <li>4. allowing myosin (heads) to attach to actin ;</li> <li>5. (contraction as) actin is pulled past the myosin / reference to sliding filament theory ;</li> </ol> | <b>MP3 ALLOW</b> this exposes the myosin binding site | <b>(3)</b> |

| Question Number | Answer                                                                                                                                                                        | Additional Guidance                                                                   | Mark       |
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| <b>3(a)(i)</b>  | <ol style="list-style-type: none"> <li>1. as age increases (median) FEV<sub>1</sub> decreases ;</li> <li>2. at lower altitudes (median) FEV<sub>1</sub> is lower ;</li> </ol> | <p><b>ACCEPT</b> converse statements</p> <p><b>MP1 ALLOW</b> negative correlation</p> | <b>(2)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                          | Additional Guidance                                                                  | Mark       |
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| <b>3(a)(ii)</b> | <ol style="list-style-type: none"> <li>1. { lungs / alveoli } lose their { elasticity / elastic tissue } ;</li> <li>2. weaker {breathing muscles / diaphragm / intercostal muscles } ;</li> <li>3. idea of respiratory disease ;</li> <li>4. idea of fewer alveoli ;</li> </ol> | <p><b>MP3 ALLOW</b> description of environmental factor e.g. more smoking damage</p> | <b>(2)</b> |

| Question Number  | Answer                                                                                                                                                                                                                     | Additional Guidance                                                                                                                                                         | Mark       |
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| <b>3(a)(iii)</b> | <ol style="list-style-type: none"> <li>1. less oxygen available / eq ;</li> <li>2. need to breathe more forcefully / eq ;</li> <li>3. stronger breathing muscles / eq ;</li> <li>4. larger lung capacity / eq ;</li> </ol> | <p><b>MP1 ALLOW</b> lower concentration of oxygen</p> <p><b>MP4 ALLOW</b> more air needs to be breathed in / breathed out / larger tidal volume / larger vital capacity</p> | <b>(2)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                               | Additional Guidance                                              | Mark       |
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| <b>3(b)</b>     | <ol style="list-style-type: none"> <li>1. (collect traces) from each group of Andean males and North American males ;</li> <li>2. (for each individual) count the number of breaths / eq ;</li> <li>3. divide by the time taken (to find the rate) ;</li> <li>4. find the middle value (for each group) ;</li> </ol> | <p><b>MP1 ALLOW</b> collect enough result to find the median</p> | <b>(3)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                  | Additional Guidance                                                                                                                      | Mark       |
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| <b>4(a)</b>     | 1. exposure to pesticide increases the risk of developing Parkinsons / eq ;<br><br>2. the more pesticides an individual is exposed to the greater the risk of developing Parkinsons / eq ;<br><br>3. correct manipulation of data to support MP1 or 2 ; | e.g. (relative) risk for P, Q and R exposed group is 2.1 greater than control group<br><br><b>IGNORE</b> simple descriptions of the data | <b>(2)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                | Additional Guidance                                                                                                                                                                                                                                            | Mark       |
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| <b>4(b)(i)</b>  | <ol style="list-style-type: none"> <li>1. idea that pesticides are {absorbed through skin / inhaled} ;</li> <li>2. idea that blood carries pesticides to the brain ;</li> <li>3. pesticide kills the dopamine secreting neurones in the (mid) brain ;</li> <li>4. {inhibits release / reduces production} of dopamine ;</li> <li>5. {binds to / blocks} post synaptic receptors for dopamine</li> <li>6. idea of effect on motor pathway ;</li> </ol> | <p><b>MP3 ACCEPT</b> basal ganglia / substantia nigra</p> <p><b>MP4 ALLOW</b> no dopamine production / not enough dopamine in the synaptic cleft</p> <p><b>MP6</b> e.g. stops impulses reaching muscle cells / reduces action potentials in motor neurones</p> | <b>(3)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Additional Guidance                                                                                                                                                                                                                                                             | Mark       |
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| <b>4(b)(ii)</b> | <p>1. reference to <b>L dopa</b> ;</p> <p>2. idea that L dopa can cross the blood brain barrier ;</p> <p>3. L dopa is converted to dopamine in the brain / eq ;</p> <p>4. dopamine binds to receptors on the post-synaptic membrane ;</p> <p>OR</p> <p>1. use an enzyme inhibitor ;</p> <p>2. reference to {<b>monoamineoxidase B / MAOB</b>} ;</p> <p>3. to prevent the breakdown of dopamine</p> <p>4. dopamine binds to receptors on the post-synaptic membrane ;</p> <p>OR</p> <p>1. reference to <b>dopamine agonist</b> ;</p> <p>2. idea that dopamine agonist can cross the blood brain barrier ;</p> <p>3. (dopamine agonist) binds to receptors on the post-synaptic membrane ;</p> | <p><b>MP2 ALLOW</b> diffuse from blood into brain</p> <p><b>MP4 ALLOW</b> idea of effect on motor pathway</p> <p><b>MP2 ALLOW</b> named MAOB e.g. selegline</p> <p><b>MP4 ALLOW</b> idea of effect on motor pathway</p> <p><b>MP3 ALLOW</b> idea of effect on motor pathway</p> | <b>(3)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                           | Mark       |
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| <b>5(a)</b>     | <p><b>The only correct answer is B – homeostasis</b></p> <p><i>A is not correct because chemiosmosis is movement of ions across a partially permeable membrane down their electrochemical gradient</i></p> <p><i>C is not correct because phototropism is the orientation of an organism in response to light</i></p> <p><i>D is not correct because respiration is the process by which living organisms produce energy</i></p> | <b>(1)</b> |

| Question Number  | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Additional Guidance                                                                                                                                                                                                                                      | Mark       |
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| <b>* 5(b)(i)</b> | <ol style="list-style-type: none"> <li>1. core temperature falls ;</li> <li>2. receptors in hypothalamus detect the change ;</li> <li>3. idea of an increase in { shivering / metabolic activity } ;</li> <li>4. increasing heat production ;</li> <li>5. once (core body) temperature increases {shivering stops / metabolic activity reduces} ;</li> <li>6. body hair insulates ;</li> <li>7. curling up reduces surface area (to volume ratio) reducing heat loss ;</li> </ol> | <p><b>QWC emphasis on clarity of expression</b></p> <p><b>MP1 IGNORE</b> body / skin temperature</p> <p><b>MP5 ACCEPT</b> negative feedback</p> <p><b>MP6 ALLOW</b> description of hair erector muscles standing hairs up to create insulation layer</p> | <b>(5)</b> |

| Question Number | Answer                                                                                                                                                                                  | Additional Guidance           | Mark       |
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| <b>5(b)(ii)</b> | <ol style="list-style-type: none"> <li>1. body mass will decrease ;</li> <li>2. fat { broken down / used as a respiratory substrate / provides energy for shivering / eq } ;</li> </ol> | <b>ALLOW</b> muscle / protein | <b>(2)</b> |

| Question Number | Answer                                                                                                                                                                                                                      | Mark |
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| 5(c)(i)         | <div><div>The only correct answer is D -</div><div><div>increases</div><div>increases</div></div><div><div>A is not correct because</div><div>B is not correct because</div><div>C is not correct because</div></div></div> | (1)  |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Additional Guidance                                                                                                                                           | Mark       |
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| <b>5(c)(ii)</b> | <ol style="list-style-type: none"> <li>1. count number of bears (living near paths) ;</li> <li>2. introduce humans (on paths) ;</li> <li>3. idea of controlling level of disturbance (by humans on paths) ;</li> <li>4. count number of bears that remain (near ) after disturbance ;</li> <li>5. idea of repeating disturbance at regular time intervals ;</li> <li>6. habituation has occurred when the number of bears (around the paths) stops decreasing after human use of paths ;</li> </ol> | <p><b>MP4 ALLOW</b> other reasonable methods of assessing response of bears</p> <p><b>MP6 ALLOW</b> other reasonable methods of demonstrating habituation</p> | <b>(4)</b> |

| Question Number | Answer                                                                                                                                                                                                         | Additional Guidance              | Mark       |
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| <b>6(a)(i)</b>  | <ol style="list-style-type: none"> <li>1. the lower the concentration of oxygen the more EPO (that is synthesised) / eq ;</li> <li>2. the longer the time the more EPO (that is synthesised) / eq ;</li> </ol> | <b>ALLOW</b> converse statements | <b>(2)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                   | Additional Guidance                                                                                                  | Mark       |
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| <b>6(a)(ii)</b> | <ol style="list-style-type: none"> <li>1. idea that low oxygen concentration triggers second messenger systems ;</li> <li>2. reference to <b>transcription factors</b> ;</li> <li>3. transcription factor binds to (the promotor region of) the EPO gene ;</li> <li>4. more (EPO mRNA) transcription ;</li> <li>5. increased (EPO) protein synthesis / eq } ;</li> </ol> | <p><b>MP1 ALLOW</b> an example of a second messenger e.g. cAMP / protein kinases</p> <p><b>MP3 ALLOW</b> EPO DNA</p> | <b>(4)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                          | Additional Guidance                                                                                                                     | Mark       |
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| <b>6(b)</b>     | <ol style="list-style-type: none"> <li>1. isolate the EPO gene (from human cells) / eq ;</li> <li>2. using restriction enzymes / eq ;</li> <li>3. insert the EPO gene into a vector / eq ;</li> <li>4. example of a vector ;</li> <li>5. insert { vector / gene } into udder of a sheep / eq ;</li> <li>6. idea of modifying several (udder) cells ;</li> </ol> | <p><b>MP4</b> e.g. plasmid / virus / bacteria</p> <p><b>MP5 ALLOW</b> insert {vector / gene} into breast cells / milk protein genes</p> | <b>(4)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                              | Additional Guidance                                                                                                                  | Mark       |
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| <b>7(a)</b>     | <ol style="list-style-type: none"> <li>1. they have a {suppressed / weakened} immune system ;</li> <li>2. identify particular aspect of immune system that could be suppressed ;</li> <li>3. idea of close contact (with others with viral infections) ;</li> </ol> | <p><b>MP2</b> e.g. produce fewer T killer cells / less antibody to virus</p> <p><b>MP3 ALLOW</b> more opportunities for injuries</p> | <b>(2)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Additional Guidance                                                                                              | Mark       |
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| <b>7(b)</b>     | <ol style="list-style-type: none"> <li>1. (boosters) contain the same antigens as the (original) vaccine ;</li> <li>2. (boosters) { stimulate more / maintain number of } memory cells ;</li> <li>3. (boosters) stimulate production of antibodies (specific for the pathogen by plasma cells) ;</li> <li>4. when infected (with the pathogen) there is a rapid immune response / eq ;</li> <li>5. eliminates the pathogen before it can infect and damage the heart cells ;</li> </ol> | <p><b>MP1 ALLOW</b> an inactive form of the virus</p> <p><b>MP5 ALLOW</b> idea that infection is less severe</p> | <b>(3)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                            | Additional Guidance                                                                                                                                                                                                                                                 | Mark       |
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| <b>7(c)</b>     | <ol style="list-style-type: none"> <li>1. work as a neurotransmitter ;</li> <li>2. binding to serotonin receptors / eq ;</li> <li>3. reference to {<b>synapses / post synaptic membrane</b>} ;</li> <li>4. in the pleasure centres of the brain / eq ;</li> </ol> | <p><b>MP2 ALLOW</b> stimulate the release of serotonin / production of serotonin / prevents the re-uptake of serotonin</p> <p><b>MP3 ALLOW</b> synaptic cleft</p> <p><b>MP4 ALLOW</b> nucleus accumbens</p> <p><b>MP4 IGNORE</b> other named parts of the brain</p> | <b>(3)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                | Additional Guidance                                                                                         | Mark       |
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| <b>7(d)</b>     | <ol style="list-style-type: none"> <li>1. cardiac muscle is weaker (in unfit heart) ;</li> <li>2. stroke volume is smaller / eq ;</li> <li>3. needs to beat faster to maintain cardiac output / eq ;</li> <li>4. to ensure a supply of oxygen to tissues ;</li> </ol> | <p><b>ALLOW</b> converse statements</p> <p><b>MP4 ALLOW</b> muscles need oxygen for aerobic respiration</p> | <b>(2)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                             | Additional Guidance                                                                                                                                                   | Mark       |
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| <b>7(e)</b>     | <ol style="list-style-type: none"> <li>1. cells forming the SAN are myogenic ;</li> <li>2. SAN receives impulses from the {cardiovascular centre / medulla } ;</li> <li>3. sympathetic nerves stimulate the SAN / parasympathetic nerves inhibit the SAN ;</li> <li>4. idea that waves of depolarisation from the (SAN) initiate contraction of the {atria / heart} ;</li> <li>5. pressure changes cause a pulse / eq ;</li> </ol> | <p><b>MP1 ALLOW</b> cells of SAN have an intrinsic rhythmicity / SAN act as the (primary) pacemaker</p> <p><b>MP4 ALLOW</b> passes an (electrical) impulse to AVN</p> | <b>(3)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                            | Additional Guidance                                                                                                                                                                                                   | Mark       |
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| <b>7(f)</b>     | <ol style="list-style-type: none"> <li>1. (some) ion channels open and allow the movement of ions ;</li> <li>2. the membrane potential becomes less negative ;</li> <li>3. reference to <b>threshold potential</b> ;</li> <li>4. causes (more) ion channels to open (depolarising the cell membrane) ;</li> </ol> | <p><b>MP1 and 4 ALLOW</b> calcium ions / sodium ions / potassium ions</p> <p><b>MP2 ALLOW</b> membrane becomes more positive / inner membrane becomes positive</p> <p><b>MP4 ALLOW</b> calcium ions / sodium ions</p> | <b>(3)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                             | Additional Guidance                                                                                   | Mark       |
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| <b>7(g)</b>     | <ol style="list-style-type: none"> <li>1. genes code for membrane protein channels ;</li> <li>2. exercise is an environmental factor ;</li> <li>3. idea that exercise does not change the number of genes ;</li> <li>4. exercise can affect ion channel {gene expression / transcription / mRNA production / synthesis} ;</li> <li>5. by { increasing / decreasing / changing } the activity of transcription factors ;</li> </ol> | <p><b>MP4 ALLOW</b> less activation of genes / less ion channel protein made / genes switched off</p> | <b>(3)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Additional Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Mark       |
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| <b>* 7(h)</b>   | <ol style="list-style-type: none"> <li>1. ribosomes on the rough endoplasmic reticulum translate (beta-1-adrenergic receptor) mRNA ;</li> <li>2. polypeptide chains are released into the endoplasmic reticulum ;</li> <li>3. transported to the Golgi apparatus ;</li> <li>4. { sugars added / carbohydrate added / glycosylation takes place } in the Golgi apparatus ;</li> <li>5. the glycoprotein is packaged into vesicles / eq ;</li> <li>6. vesicles fuse with the cell membrane ;</li> <li>7. idea of inserting the beta-1-adrenergic receptor into the (cell) membrane ;</li> </ol> | <p><b>QWC emphasis is for logical sequence</b></p> <p><b>MP1 ALLOW</b> description of translation that includes role of ribosomes on rER</p> <p><b>MP2 ALLOW</b> primary structure enters the ER</p> <p><b>MP3 ALLOW</b> Golgi body</p> <p><b>MP4 ALLOW</b> protein is converted into a glycoprotein in the Golgi</p> <p><b>MP4 IGNORE</b> glycogen added</p> <p><b>MP5 ALLOW</b> vesicles with (beta-1-adrenergic receptor) in their membrane leave the Golgi / glycoproteins leave the Golgi in vesicles</p> | <b>(5)</b> |

| Question Number | Answer                                                                       | Additional Guidance                                                                                                                                                                                                                                                                                                                          | Mark       |
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| <b>7(i)</b>     | 1. distance between peaks will increase / peaks will be less frequent / eq ; | <b>ALLOW</b> any named peak (P, Q, R, S, T)<br><br><b>ALLOW</b> increase in length of interval between any pair of letter P, Q, R, S and T<br><br><b>ACCEPT</b> correct annotated diagram<br><br><b>ALLOW</b> shorten the QT interval (in some) ;<br><br><b>IGNORE</b> fewer peaks<br><br><b>IGNORE</b> descriptions of heart beats or pulse | <b>(1)</b> |

| Question Number | Answer                                                                                                                                                            | Additional Guidance                                                                                                        | Mark       |
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| <b>7(j)</b>     | 1. adrenalin is absorbed into the blood stream / eq ;<br><br>2. causes (smooth) muscle in blood vessels to contract ;<br><br>3. resulting in reduced blood flow ; | <b>MP2 ALLOW</b> causes vasoconstriction<br><br><b>MP2 IGNORE</b> causes capillaries to constrict / blood vessels contract | <b>(2)</b> |

| Question Number | Answer                                                                                                                                                                                                                                                                                             | Additional Guidance                                                                                                | Mark       |
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| <b>7(k)</b>     | <ol style="list-style-type: none"> <li>1. atropine inhibits nerve impulses in the parasympathetic system ;</li> <li>2. the sympathetic system still functions ;</li> <li>3. this causes contraction of the radial muscles ;</li> <li>4. circular muscles {are not stimulated / relax} ;</li> </ol> | <p><b>MP1 ALLOW</b> stops / inhibits parasympathetic system</p> <p><b>MP3 IGNORE</b> retinal / radical muscles</p> | <b>(3)</b> |

